HIRG

Annual RHIC DOE Science and Technology Review
July 19, 2007

F. Videbaek

Physics Department

BNL

Overview

- **Group Overview**; people
  - Activity, responsibility
  - Group members have or are planning activities in PHENIX and STAR.
- PHOBOS, BRAHMS and ATLAS
  - **Productivity** (papers, talks, committee's..)
  - **Accomplishments, highlights**
  - **Plans**
- Summary

HIRG
Scientific Activity

People

- M.D. Baker (ATLAS,PHOBOS, PHENIX)
- D.Beavis (BRAHMS, STAR)
- C.Chasman (BRAHMS, STAR)
- R.Debbe (BRAHMS, ATLAS, STAR)
- JH.Lee (BRAHMS, ATLAS, STAR)
- R. Nouicer (ATLAS,PHOBOS,PHENIX)
- P. Steinberg (ATLAS,PHOBOS,PHENIX)
- J.Jia (PHENIX, ATLAS) joint appointment with SUNYSB-CHM
- F.Videbaek (BRAHMS,STAR,ATLAS)

The BRAHMS and PHOBOS activities are winding down. The others taking over in significant amount.

Future activities are divided efforts with typically ~50/50 division per person

The group is formed to consolidate the efforts for HI in ATLAS.

Members will be continue to be involved in the RHIC program.

Major responsibilities (snapshot for FY07)

- Baker
  - HIRG Deputy Group Leader
  - PHOBOS Nuclear fragments paper IRC Chair
  - US-ATLAS-HI Gamma-ID working group convenor
- Nouicer
  - PHOBOS Multiplicity Working Group co-convenor
  - PHOBOS Flow IRC (Internal Review Committee) member
  - PHOBOS Silicon detector co-coordinator (decommissioning)
  - PHOBOS Council Member
  - PHENIX, Deputy Manager for VTX strip detector
    - Training 8 students/postdocs from Stony Brook & Iowa State
- Steinberg
  - PHOBOS Project Manager (decommissioner)
  - PHOBOS Computing Coordinator
  - PHOBOS Multiplicity correlation IRC Chair
  - PHOBOS Trigger particle correlation IRC member
  - US-ATLAS-HI Global Observables coordinator
  - US-ATLAS-HI Computing coordinator
  - PHENIX Silicon database coordinator

- Beavis
  - BRAHMS project manager (decommission)
  - STAR pp2pp installation manager
  - CA-D radiation safety Chair
- Chasman
  - BRAHMS Council member
  - BRAHMS high-pt pp, dA PC-member (Paper Committee)
- Debbe
  - BRAHMS high-pt pp,dA PC-chair
  - US-ATLAS-HI tracking group convenor
- JHLee
  - BRAHMS Transverse Spin PC-chair
  - BRAHMS Analysis working group co-convenor
- Videbaek
  - HIRG group leader
  - BRAHMS spokesperson
  - BRAHMS Analysis working group co-convenor
  - STAR HFT project scientific deputy manager

Invited Talks

- QM06, Shanghai
  - JH.Lee ,R.Nouicer and P.Steinberg
- SPIN 2006, Kyoto
  - JH.Lee
- DIS 2007 4/2007, Munich
  - JH.Lee
- Valpariso 12/2006, Chile
  - F.Videbaek
- Jyvaskula 3/2007 , Finland
  - P.Steinberg
- Winter workshops
  - R.Nouicer, F.Videbaek
- +others

Total: ~16 talks at international meetings and workshops with ~11 proceedings published.

PHOBOS Papers (since July 2006)

8 PHOBOS papers submitted and/or published since July 1, 2006.
Significant BNL group involvement in all of them.
Total PHOBOS citations ~ 1950

- **PRC75 (2007) 054913** Steinberg IRC (Internal Review Committee) chair
  - Cluster properties from two-particle angular correlations in p+p collisions at sqrt(s) = 200 and 410 GeV
- **PRL (2007 – in press),** Baker, Steinberg invented participant eccentricity (ε_{part})
  - Elliptic flow fluctuations in Au+Au collisions at sqrt(s_NN) = 200 GeV
- **PRL 98(2007) 242302** Baker, Steinberg invented ε_{part}, Baker, Nouicer on IRC
  - System Size, Energy, Pseudorapidity, and Centrality Dependence of Elliptic Flow
- **PRC 75 (2007) 024910** Steinberg on IRC
  - Identified hadron transverse momentum spectra in Au+Au collisions at sqrt(s_NN)=62.4 GeV
- **PRC 74 (2006) 021902R**, Steinberg lead author, Baker, Steinberg Multiplicity Working Group co-conveners
  - Centrality and Energy Dependence of Charged-Particle Multiplicities in Heavy Ion Collisions in the Context of Elementary Reactions
- **PRC 74 (2006) 011901R**, Steinberg lead author
  - Forward-Backward Multiplicity Correlations in sqrt(s_NN)=200 GeV Au+Au Collisions
- **PRL 97 (2006) 012301,** Nouicer on IRC.
  - Energy dependence of directed flow over a wide range of pseudorapidity in Au+Au collisions at RHIC
- **PRC 74 (2006) 021901R,** Steinberg lead author, Nouicer, Multiplicity Working Group co-convener
  - Charged Particle Pseudorapidity Distributions in Au+Au collisions at sqrt(s_NN) = 62.4 GeV

BRAHMS papers (since July 2006)

3 BRAHMS papers submitted and/or published since July 1, 2006.
Significant BNL group involvement.
Total BRAHMS citations ~ 1180

- **Phys. Rev. Lett. 98, 252001 (2007) PRC.** Debbe PC (Paper Committee) chair, lead author

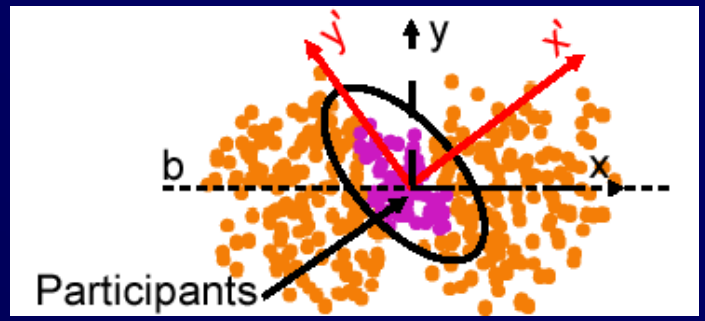
  "Production of Mesons and Baryons at High Rapidity and High Pt in Proton-Proton Collisions at Sqrt{s} = 200 GeV“
- Phys.Lett.B650,217(2007)
  - “Nuclear Modification Factor for Charged Pions and protons at Forward rapidity in Central Au+Au Collisions at 200 GeV"
- Nucl. Instr. Meth A570 216 (2007), Debbe Lead author

  "The BRAHMS ring imaging Cherenkov detector"

Highlights PHOBOS

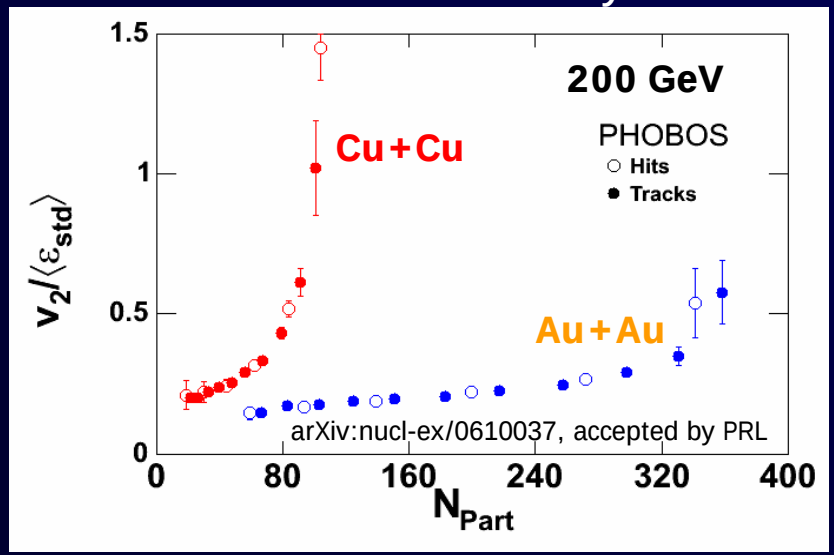
ε_{part} unifies flow in Cu+Cu and Au+Au

Baker, Steinberg co-inventors
Baker, Nouicer on IRC

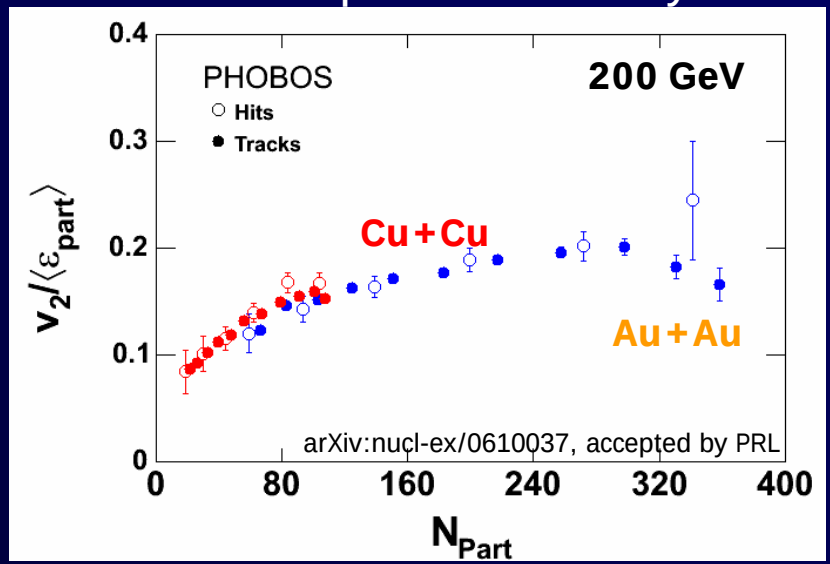


$$\left\langle \varepsilon_{\text{part}} \right\rangle = \frac{\sqrt{\left(\sigma_y^2 - \sigma_x^2\right)^2 + 4\sigma_{xy}^2}}{\left(\sigma_y^2 + \sigma_x^2\right)}$$

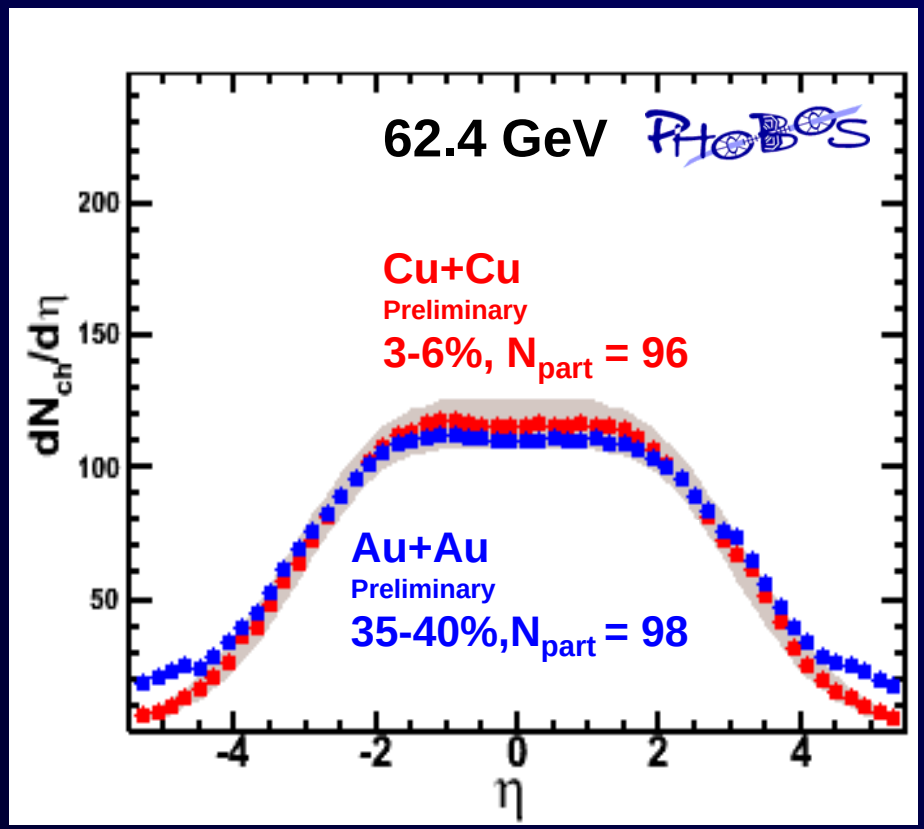
Standard Eccentricity

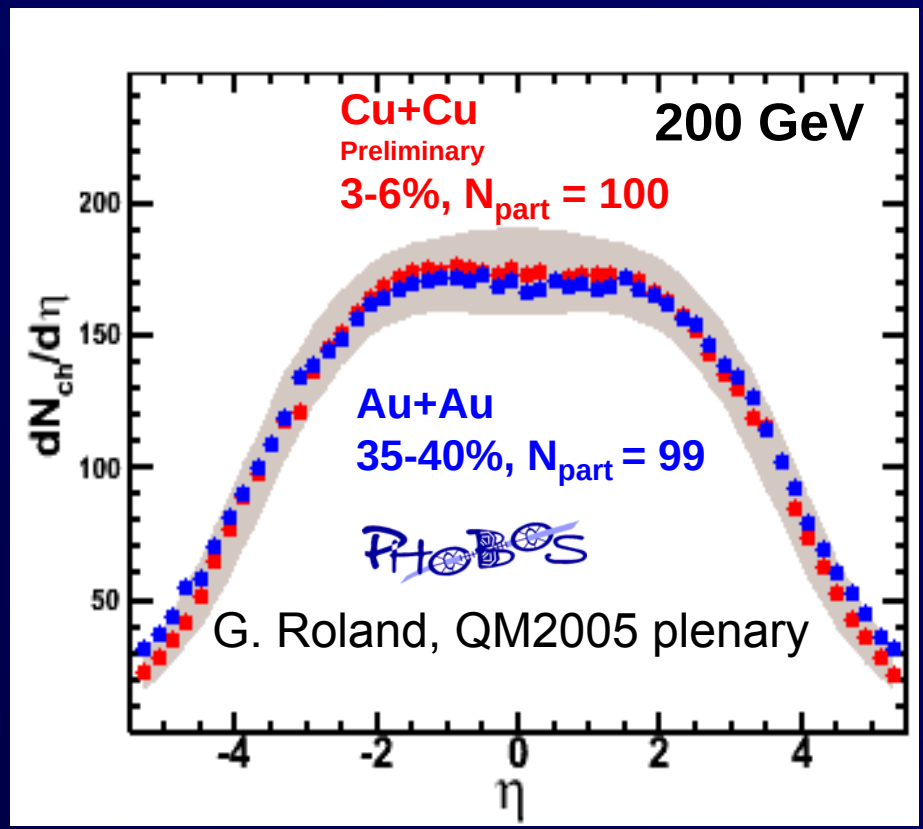


Participant Eccentricity



dN/dη in Cu+Cu vs Au+Au





Unscaled dN/dη very similar for Au+Au and Cu+Cu at same N_{part}

Nouicer:
Working Group co-convener
Upcoming paper lead author

PHOBOS Plans

- The collaboration has plans for about 15 more papers.
  - "Multiplicity" papers – Nouicer MWG co-convener
    - 2 CuCu dN/dη papers – Nouicer lead author of one
    - PHOBOS dN/dη long paper
    - PHOBOS nuclear fragments paper at high η – Baker IRC chair
    - Proton-proton dN/dη
  - Elliptic flow – Nouicer on IRC
    - CuCu $v_2(p_T)$ paper
    - PHOBOS flow long paper
  - Participant eccentricity systematics – Baker, Steinberg
  - **Large-acceptance** two-particle correlations $(\Delta\eta,\Delta\phi)$
    - Global correlations – Steinberg IRC chair
    - Correlations with trigger particle – Steinberg IRC member
  - & 5 others – analysis/computing supported at BNL (Steinberg)
- PHOBOS nearly decommissioned. IR to be vacated by end of July 2007.

Highlights BRAHMS

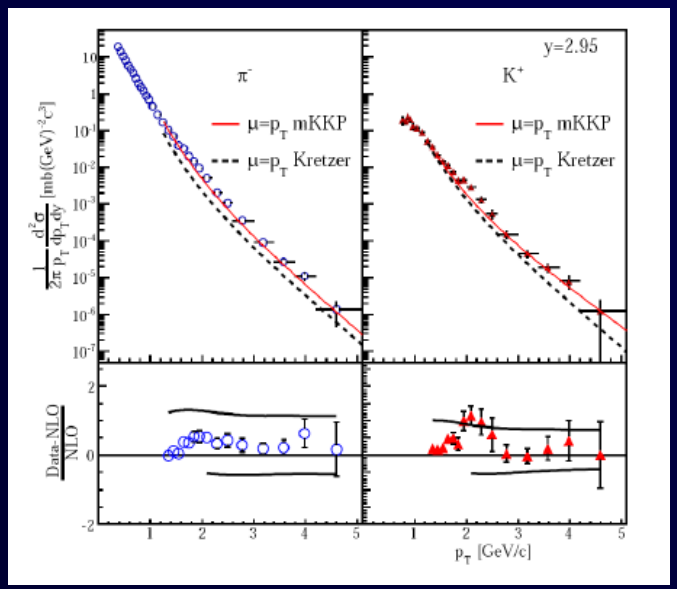
High rapidity studies in pp

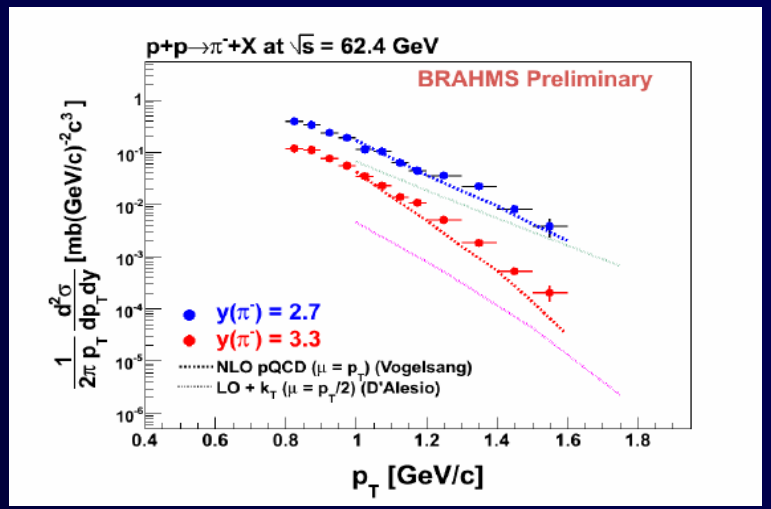
Precision studies of identified hadrons at high rapidity and comparison to pQCD.

Demonstrates applicability at high y.

Provides important input to determination of fragmentation functions.

Debbe, Chasman, Videbaek

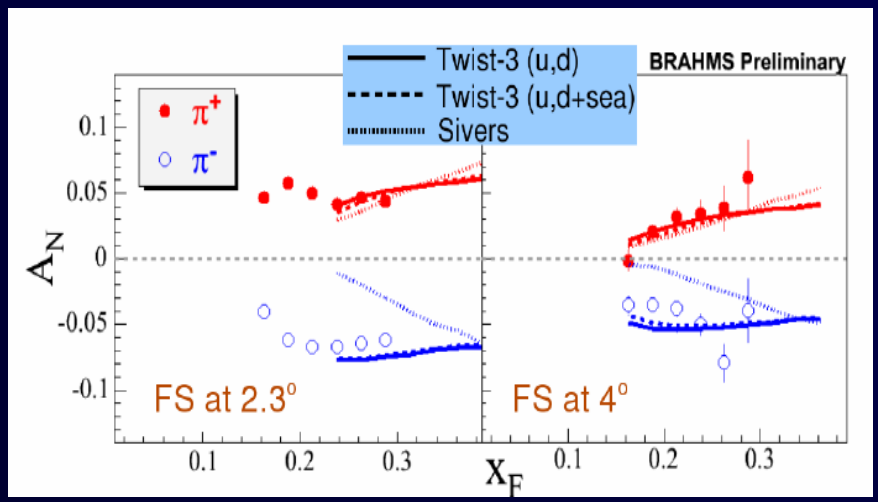


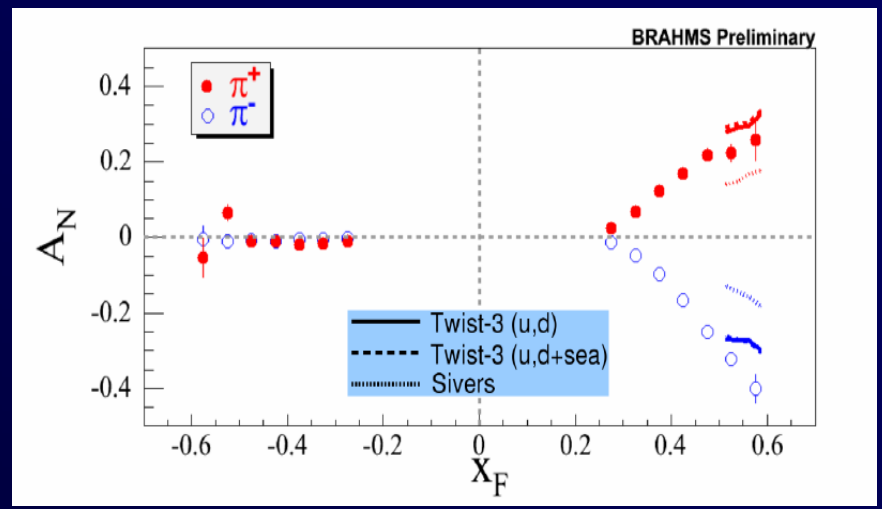


Transverse Single Spin Asymmetries

- Measurement from run-5 and run-6 at large x_F.
- Towards understanding orbital angular momentum in the proton.
- Valuable interaction with theorists at BNL and abroad.

JH.Lee, Videbaek





BRAHMS Plans

- The collaboration has plans for about 12 more papers.
  - Spectra papers
    - dAu identified hadrons Debbe PC chair.
    - Stopping in AuAu, pp JHLee PC member
  - Elliptic flow –AuAu $v_2(p_T)$ paper
  - Intermediate pt spectra for identified hadrons
  - Transverse Spin – JHLee, Videbaek, Chasman
    - 62.4 Gev and 200 GeV
  - Spectra in pp
    - 62 GeV – Videbaek PC chair
    - 200 GeV -
  - & 5 others –
  - analysis/computing supported at BNL (JHLee,Videbaek)
- Decommissioning of experiment has begun; will continue throughout FY08.

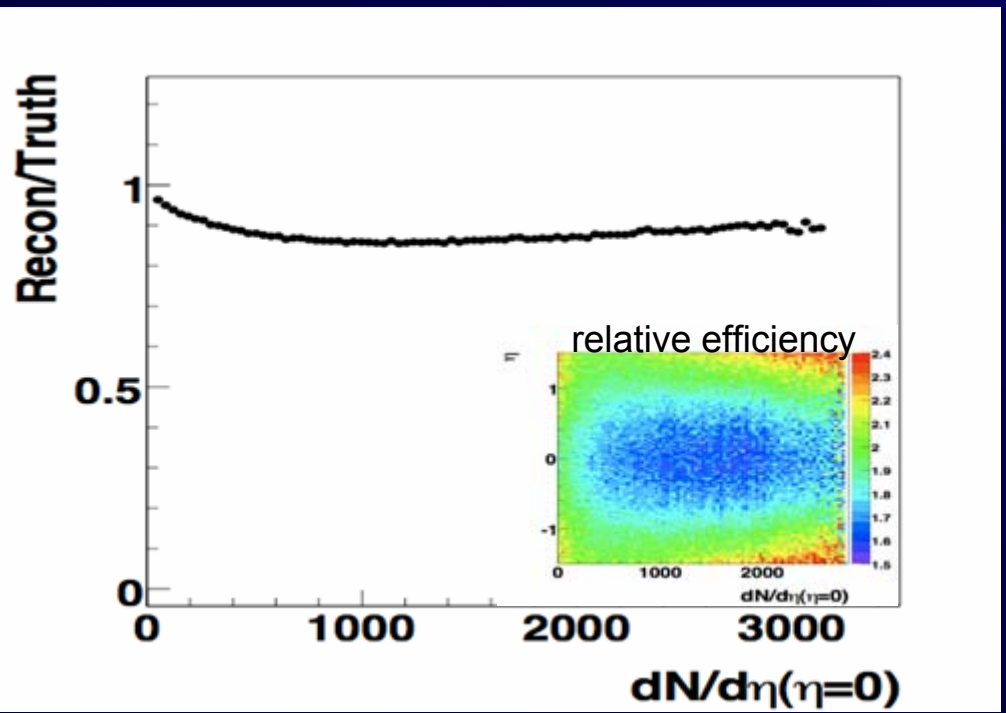
Heavy Ions in ATLAS

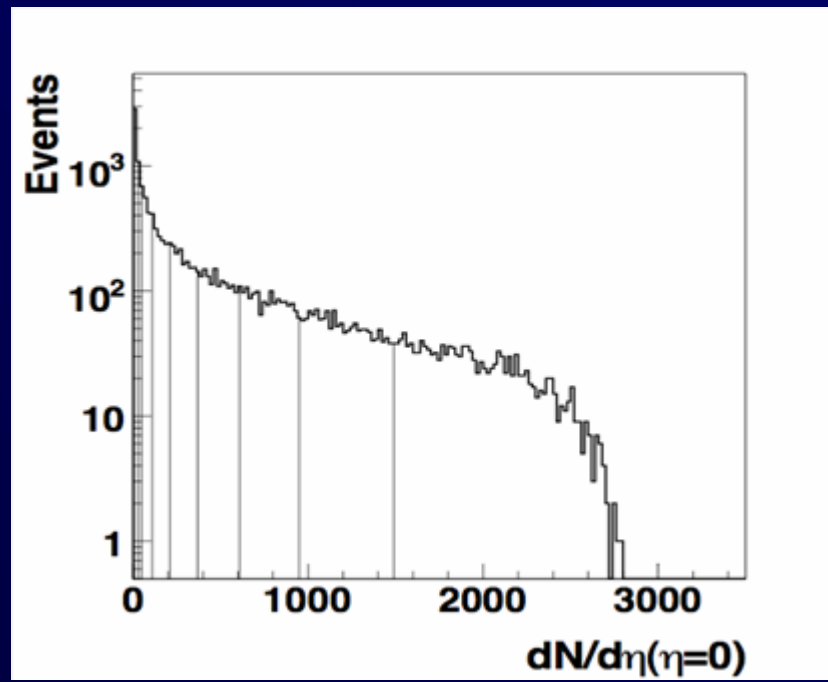
- It is beneficial to have strong BNL group ATLAS HI.
  - BNL is the intellectual center for experimental heavy Ion physics and should be directly coupled to the program at CERN.
  - Provide link and interaction with BNL HEP physicist and analysis support groups at BNL.
  - Should not miss opportunity to be part of new efforts.
- BNL group is part of US-ATLAS effort.
  - Columbia (5)
  - SUNYSB (4)
  - Iowa State (3)
- Group formed of BRAHMS and PHOBOS members. Current effort is ~2.2 FTE.
- All group members are now in the Physics Department.
- Works on day-1 physics, global properties, tracking, e/gamma.

Studying global features of HI

- Global variables: charged multiplicity, centrality, elliptic flow
- Characterizing bulk properties of medium, e.g. entropy, EOS

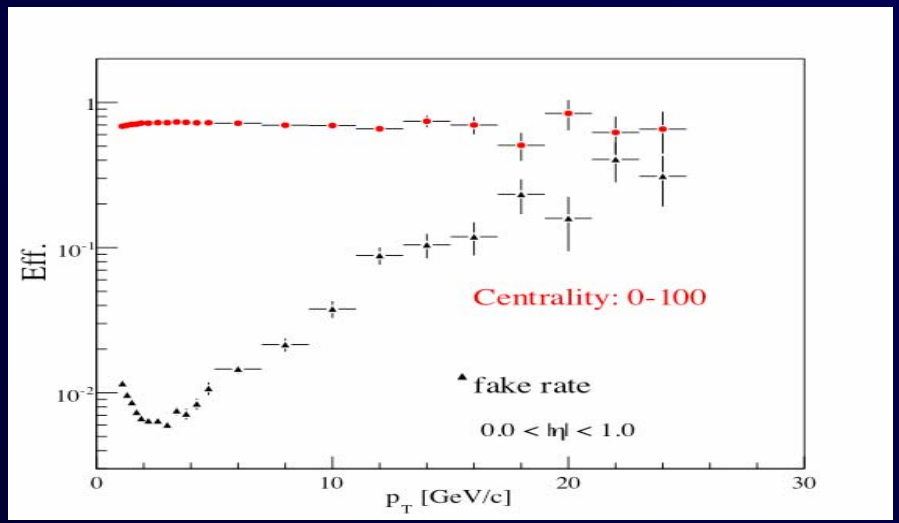
Steinberg





Studying tracking for HI in ATLAS

- Evaluation and development of tracking software in Heavy Ion environment
- Using up-to date ATLAS software and GRID tools
- The high granularity of the PIXEL and SCT detectors translates into a satisfactory tracking efficiency for HI (~70%).
- Jet-modification, fragmentation functions

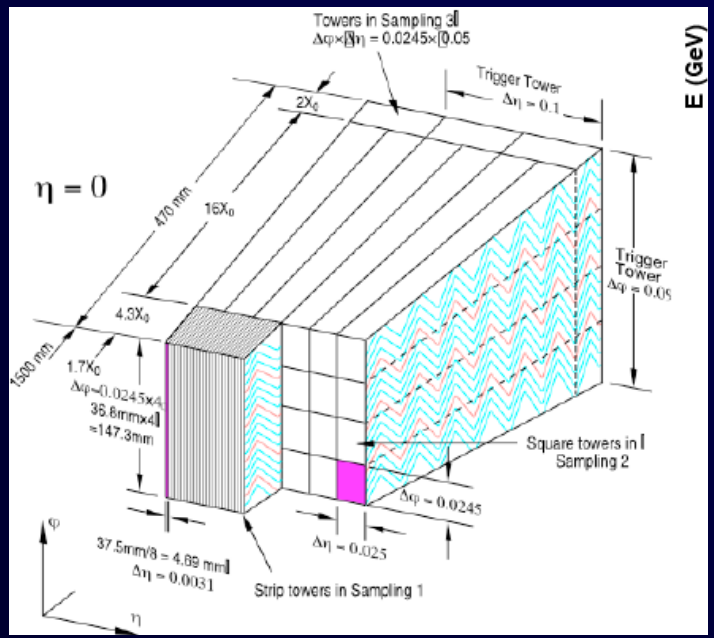


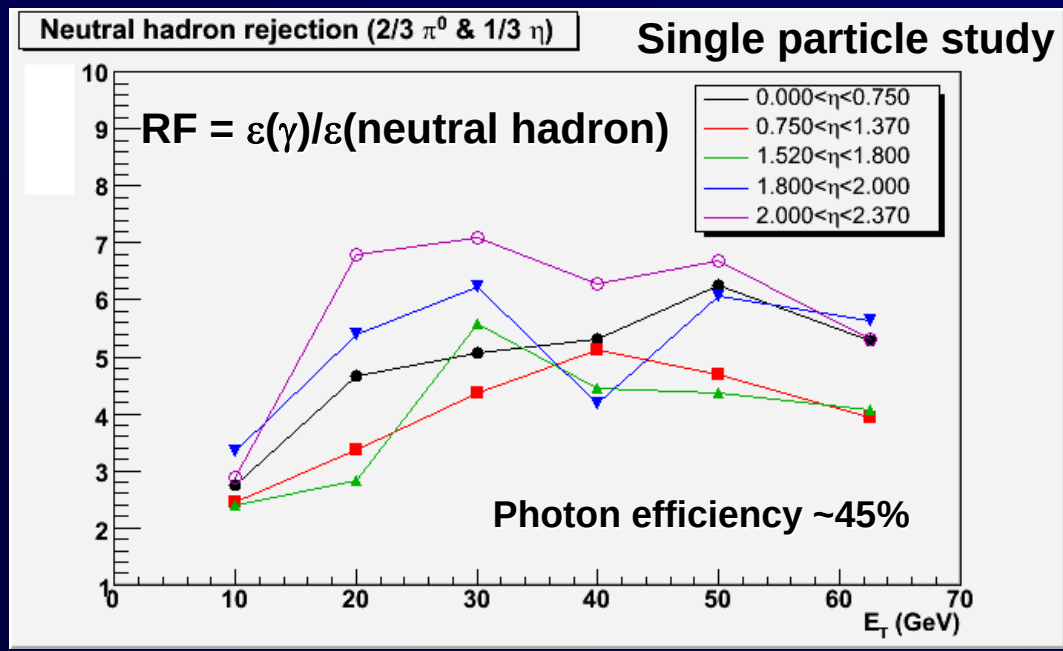
Debbe

Studying unique ATLAS feature: γ ID

- Longitudinally segmented large-acceptance EMCAL w/ precision strips (in η direction).
- Will allow us to reject high pT π^0's & η's to identify direct γ's
  - Direct γ rate measurement
  - Purify γ+jet sample (from j+j→π^0X+j background): **Precision study of jet quenching in medium!**

Baker





US-ATLAS-HI plans

- Ongoing discussion with BNL management and DOE concerning participation in ATLAS HI
- Proposal in preparation (submission expected September)
  - Highlighting unique physics and opportunities
  - Request for M&O, travel support and Computing support
- Active in Physics Performance Report for HI in ATLAS
- Level of effort at BNL will be determined from response to proposal by end this year.

Summary

- The Heavy Ion Group has an active, diverse and important research program going.
- The group is productive with publications and talks in the community.
- The group is in transition from the PHOBOS/BRAHMS research to activities with HI ATLAS and a concurrent program at RHIC within the upgrade program of STAR and PHENIX.
- The group will like to have junior staff (post docs) and visitors associated with the research group.